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A UK portrait of wind-induced undercatch in rainfall measurement

Michael Pollock (1,2), Paul Quinn (1), Greg O'Donnell (1), Matteo Colli (2), Mark Dutton (3), Andrew Black (4), Mark Wilkinson (5), Chris Kilsby (1), Mattia Stagnaro (3), Luca Lanza (3), and Enda O'Connell (1)

(1) Newcastle University, Civil Engineering and Geosciences, Newcastle, United Kingdom (m.d.pollock@ncl.ac.uk), (2) EML, Newcastle-Upon-Tyne, United Kingdom (michael@emltd.net), (3) WMO/CIMO Lead Centre on Precipitation Intensity, University of Genova, Genoa, Italy (matteo.colli@unige.it), (4) University of Dundee, Dundee, United Kingdom (a.z.black@dundee.ac.uk), (5) James Hutton Institute, Aberdeen, United Kingdom (Mark.Wilkinson@hutton.ac.uk)

Rainfall is vital to life; civilisation depends upon it. Changing local and regional rainfall regimes toward more intense storm events (e.g. in the UK), increases the existing challenge of accurately measuring and modelling rainfall. Data from rain gauges, often considered to provide the most accurate practicable measure of precipitation at a point in space in time, play a critical role. They are used for, inter alia, flood forecasting and flood risk management; radar calibration and numerical weather prediction models; urban planning and drainage; and water resource management and hydrological modelling. Despite the key importance of these measurements, they remain susceptible to fundamental sources of systematic error which are often not considered when rainfall data are used. Inaccuracies in measurements are compounded in modelling applications by producing potentially misleading or incorrect results; it is therefore of great importance to understand and present uncertainty in observations. Standard practice is to mount rain gauges above the ground surface. This configuration obstructs the prevailing wind which causes an acceleration of airflow above the orifice. Precipitation is deflected away from the orifice and lands 'downstream' of the area represented by the gauge measurement, reducing its collection efficiency (CE). This phenomenon is commonly referred to as 'wind-induced undercatch'. The physical shape of a gauge bears a significant impact on its CE. Computational Fluid Dynamics (CFD) simulations are used to investigate how different shapes of precipitation gauge are affected by the wind. CFD modelling is supported by high-resolution field measurements at several exposed 'Hydro-Met' research stations in the UK. These sites are occupied by rain gauges which are scrutinised in the CFD analyses. The reference measurements at all sites are made within a WMO reference pit, where the rain gauge is mounted with its orifice at ground level and surrounded by an appropriate grid structure. 'Undercatch' exhibited within UK storms, not captured by operational gauge networks in the UK, is quantified and presented in this study. Results from CFD modelling and the field studies show that gauge shape and mounting height significantly affect the extent of the undercatch. 'Aerodynamic' gauges following a 'champagne flute' or a 'funnel' profile were demonstrated by both to have significant advantages over conventional gauge shapes, in terms of improving the CE. This study presents the latest analyses, and proposes the possible extent of rainfall underestimation within the UK, with particular reference to its hydrology.